

Death and Injury Rates of U.S. Military Personnel in Iraq

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ABSTRACT In the first 6.5 years of Operation Iraqi Freedom (OIF), U.S. military casualties exceeded 3,400 hostile deaths, 800 nonhostile deaths (due to disease, nonbattle injury, and other causes), and over 31,000 troops wounded in action. Casualty rates in Iraq have been considerably lower than during the Vietnam conflict, and a greater proportion of troops wounded in Iraq survive their wounds. Before the surge in troop levels that began in early 2007, the survival rate was 90.4% in Iraq as compared to 86.5% in Vietnam. Wounded-in-action rates increased during the first few months of the surge, but declined below presurge levels after the number of U.S. brigades in Iraq climbed from 15 to its maximum level of 20. Wounds during the surge were somewhat more lethal than previously, but because there were fewer wounding incidents the net effect was a reduction in the hostile death rate.

INTRODUCTION

The second U.S. invasion of Iraq—Operation Iraqi Freedom (OIF)—began on March 19, 2003. In the ensuing 6.5 years, the U.S. military sustained over 3,400 hostile deaths, 800 nonhostile deaths, and 31,000 wounded in action (WIA).^{1,2} The Department of Defense (DoD) regularly reports cumulative numbers of casualties along several dimensions such as service branch, geographical location, and mechanism of injury. For several reasons, DoD's casualty statistics and their portrayal in the press have not always been in the ideal format to answer the policy questions at hand. First, by design, DoD's casualty statistics do not include certain nonhostile injuries. Second, several researchers have estimated the proportion of troops wounded in Iraq who survive their wounds (survival rates), and benchmarked them against rates from Vietnam and earlier conflicts. However, those researchers have not always used comparable measures for the various conflicts. Third, death and injury rates may have been higher during the surge in Iraq (February 2007 through July 2008) than before it, but that distinction is lost in cumulative reports. Last, although not all nonhostile ("accidental") deaths in a large deployed population should be attributed to the war, commentators have not adjusted for baseline death rates pertaining to active duty service members during peacetime.

In the first part of this article, I explain the nuances of DoD's casualty classification system. Next I estimate presurge death and injury rates for Iraq and previous conflicts, and discuss why different calculations are useful for different purposes. Then I compare the presurge casualty rates for Iraq to those during the surge. In the last section I estimate the baseline nonhostile death rate for active duty personnel, which I use to adjust the number of nonhostile deaths in the Iraq theater.

DOD'S CASUALTY CLASSIFICATION SYSTEM

Although members from all military branches have been killed or injured during the war in Iraq, I use the term "soldiers"

broadly to include not only Army personnel but also sailors, airmen, and marines. DoD defines a "casualty" as any soldier who is lost to his or her organization or unit. DoD classifies casualties as "hostile" if sustained as the direct result of combat between U.S. forces and opposing forces, or if sustained going to or returning from a combat mission if the occurrence was directly related to that mission; this definition excludes injuries or deaths due to the elements, self-inflicted wounds, or combat fatigue.³

DoD's published casualty statistics further distinguish three categories of hostile casualties, depending on whether and where the injured soldiers die:

- Killed-in-action (KIA): those who die immediately on the battlefield.
- Died-of-wounds (DOW): those who survive injury on the battlefield, but die after admission to a medical treatment facility.
- Wounded-in-action (WIA): those who survive their injuries beyond initial hospitalization.⁴

On its Web sites that tabulate casualties in Operation Iraqi Freedom and Operation Enduring Freedom (OEF—Afghanistan), DoD also reports nonhostile fatalities, which it treats as an additional category of casualties (Figure 1).^{1,2} (DoD does not report nonhostile, nonfatal injuries on those Web sites—thus they are excluded from the box in Figure 1—although some of those injuries are reflected in the medical evacuation statistics reported on those Web sites.) Finally, DoD does not make any adjustment or notation in its casualty reports for baseline death and injury rates that soldiers might experience during peacetime.

PRESURGE DEATH AND INJURY RATES

Estimation of the Population at Risk

Expressing deaths and injuries as a rate requires measuring exposure: the number of person-years at risk. Because deaths and injuries occur throughout the year and troop levels vary, a single point-in-time inventory would provide a poor measure of exposure. Nor would it be satisfactory to count the total

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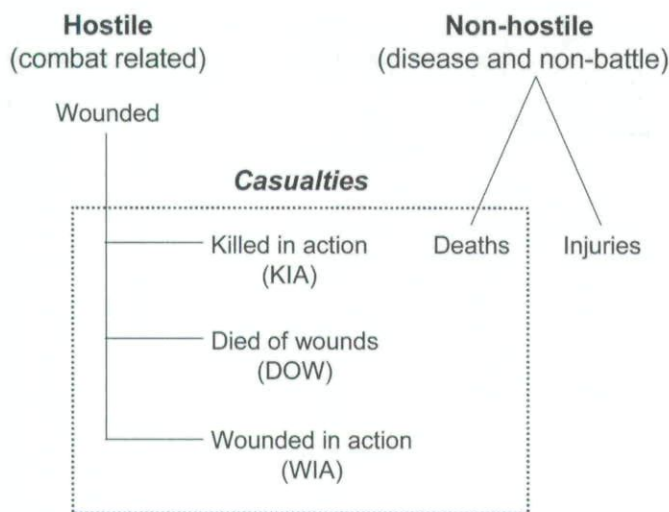


FIGURE 1. Classification of U.S. military casualties for public reporting.

number of troops passing through the combat theater during 1 year, because some troops remain for an entire year (the Army recently shifted from 15-month to 12-month deployments) but others are exposed for much shorter periods (the Marine Corps generally rotates units every 7 months).

I adapted the algorithm for measuring exposure developed by the demographers Preston and Buzzell, who analyzed mortality for U.S. military personnel in Iraq during the first 3.5 years of combat.⁵ They began by linearly interpolating the end-of-quarter inventory levels in the Iraq theater that DoD publishes on-line, thus obtaining a continuous approximation to deployed military strength.⁶ Next they computed the area under the continuous approximation and thereby estimated that U.S. troops had experienced about 675,000 person-years of exposure in Iraq through September 2006. I augmented Preston and Buzzell's work by interpolating and plotting the months between DoD's quarterly reports, after which I used more recent reports to extend the calculations through July 2008. The KIA/DOW rate increased during the early months of the surge that took place between February 2007 and July 2008: the cumulative KIA/DOW line climbed faster than the line representing cumulative exposure (Figure 2). Later in the surge, the number of KIA/DOW leveled off and the rate declined to below the presurge level. I will say more about the surge below.

Casualty Rates in Iraq and Vietnam

Using the cumulative person-years methodology, casualty rates have been much lower during OIF than they were in Vietnam, when the total death rate was 5.4 times as high and the total WIA rate was 3.7 times as high (Table I). Note that casualties as defined by DoD composed only one-fifth of all aeromedical evacuations from Iraq. That there were about four times as many evacuations for disease and nonbattle injuries (DNBIs) as for battle injuries has been noted previously by Sanders et al.⁷

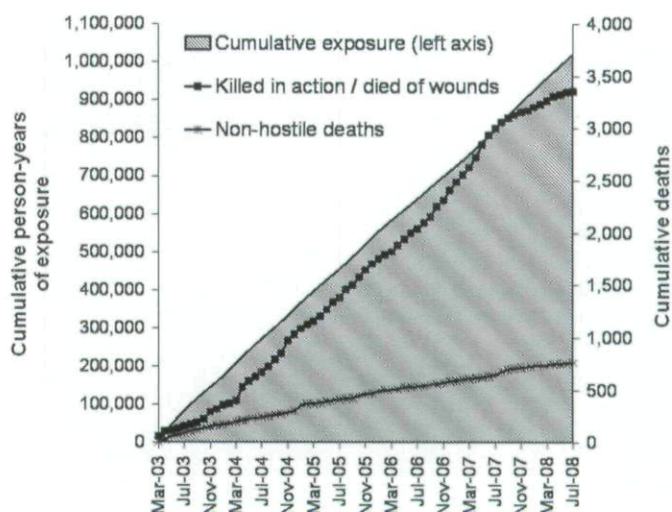


FIGURE 2. Cumulative person-years of exposure and deaths among U.S. military personnel in the Iraq theater.

The shares of deaths and injuries by type through January 10, 2007 are depicted in Figure 3. The areas of the two concentric circles in the upper portion of the figure are proportional to the number of hostile deaths and the total number of deaths, respectively. The concentric circles in the lower portion of the figure are on a more compressed scale, with areas proportional to the various types of woundings, as well as (in the outer, shaded ring) an additional 24,823 DNBIs requiring medical air transport. Some 45% of battle wounds have been of such severity that the soldier could not return to duty within 72 hours; of those, two-thirds have required medical air transport.

Considering Alternative Rate Calculations

Through January 2007, the wounded-to-fatality counts in Iraq stood at a ratio of 7.6 to 1 (Table II). That ratio is higher than during earlier U.S. military conflicts, such as the ratio of 5.2 for Vietnam. Improved survival in Iraq is due to factors such as advanced body armor, the innovative use of forward aid stations located closer to the combat units, and advances in aeromedical evacuation.¹¹ However, differences in analytical methodology have clouded some comparisons between the wounded-to-fatality ratio for OIF and for Vietnam or other earlier conflicts.

In fact, there are several ways to calculate both the numerator and denominator of the wounded-to-fatality ratio, depending on the purpose at hand. Because only troops wounded in action are included in DoD's casualty count—not those suffering DNBIs—it could be argued that the denominator should include hostile deaths only. Substituting the 2,417 hostile deaths in Iraq for the 3,001 total deaths results in a definitionally higher ratio of 9.4 to 1 (second row of Table II).

If the objective is to measure the ability of U.S. troops to survive serious wartime wounds, it can be argued that once the denominator is restricted to hostile deaths, the numerator should be restricted to wounds of such severity that soldiers

TABLE I. U.S. Military Casualties Sustained in Operation Iraqi Freedom (Through January 10, 2007) and in the Vietnam Conflict^a

	Operation Iraqi Freedom		Vietnam Conflict	
	Number ^b	Rate per 100,000 per year	Number ^c	Rate per 100,000 per year
Person-Years of Exposure ^d	721,220	NA	2,608,650	NA
Deaths				
Hostile (killed in action or died of wounds)	2,417	335	47,434	1,818
Nonhostile	<u>584</u>	<u>81</u>	<u>10,786</u>	<u>413</u>
Total deaths	3,001	416	58,220	2,231
Wounded in Action				
Returned to duty <72 hours	12,643	1,753	150,341	5,763
Not Returned to Duty, 72 Hours				
Medical air transport required	6,670	925		
Medical air transport not required	<u>3,521</u>	<u>488</u>		
Total, not returned to duty	<u>10,191</u>	<u>1,413</u>	<u>153,303</u>	<u>5,877</u>
Total Wounded in Action	22,834	3,166	303,644	11,640
Memorandum:				
Medical Air Transport				
Wounded	6,670	925		
Nonhostile injuries	6,640	921		
Disease	<u>18,183</u>	<u>2,521</u>		
Total evacuations	31,493	4,367		

^aData reproduced from Congressional Budget Office.⁸ ^bEstimates of casualties sustained in Operation Iraqi Freedom are from the start of that operation (March 19, 2003) through January 10, 2007. The Iraq theater of operations includes the Arabian Sea, Bahrain, Gulf of Aden, Gulf of Oman, Iraq, Kuwait, Oman, Persian Gulf, Qatar, Red Sea, Saudi Arabia, and United Arab Emirates. Casualties suffered by Department of Defense civilian personnel and contractors are excluded from the table. ^cEstimates of casualties sustained during the Vietnam conflict are from two DoD Web sites.^{9,10} ^dPerson-years of exposure in Vietnam are taken from Preston and Buzzell.⁵ Person-years of exposure in Iraq represent the author's extension through January 10, 2007 of Preston and Buzzell's estimate through September 30, 2006.

could not return to duty within 72 hours. Because only 45% of the woundings in Iraq have met that criterion (a factor that has remained remarkably constant during OIF), the wounded-to-fatality ratio is cut by more than half using that computation method.

Linda Bilmes examined the same underlying data through January 2007, and asserted that the wounded-to-fatality ratio in Iraq was 16 to 1.¹² In a newspaper editorial she reasserted that ratio, as compared to ratios below 3.0 in the Vietnam and Korean wars and below 2.0 during World Wars I and II.¹³ In her widely cited book with Joseph Stiglitz in which they estimate the cost of the Iraq war, they reported a slightly lower wounded-to-fatality of 15 to 1 in Iraq, but still over five times the ratio of 2.6 that they reported for Vietnam.¹⁴ To obtain such high ratios for Iraq, the numerator must equal total wounded in action (22,834) plus evacuations for nonhostile injuries (6,640) plus evacuations for disease (18,183). That numerator corresponds to the outermost circle in the lower portion of Figure 3, and the denominator corresponds to the outer circle in the upper portion of the same figure.

Bilmes used a much wider definition of the word "casualty" than does DoD. Including the total number of troops medically evacuated from the Iraq theater for any reason has merit when, for example, projecting the medical resources that DoD and the Department of Veterans Affairs will require to care for veterans of the Iraqi conflict. However, that approach is problematic for benchmarking against earlier conflicts because it exaggerates the rate at which the current generation of soldiers survives their injuries.

It is well-known that the U.S. military suffered about 58,000 deaths in Vietnam, of which 47,000 were the result of hostile action. There were also 153,000 battle injuries requiring hospital care. Lesser known, but still publicly accessible, is that there were an additional 150,000 battle injuries in Vietnam of lesser severity that did not require hospitalization (see Table I).^{10,15} Because the categories have changed over time and may not map precisely, I equate battle injuries in Vietnam not requiring hospital care with battle injuries in Iraq after which the soldier was able to return to duty within 72 hours. Conversely, I liken soldiers hospitalized during Vietnam with soldiers in Iraq who were unable to return to duty within 72 hours. With these approximations, the various wounded-to-fatality ratios are higher than in the current conflicts (whether or not Afghanistan is included) than in Vietnam (see Table II), but not nearly as different as suggested by Stiglitz and Bilmes.

As already mentioned, to obtain a 16 to 1 ratio for Iraq one must include both minor and major woundings in the numerator, as well as troops who were medically evacuated because of DNBIs—all four concentric rings in the lower portion of Figure 3. However, Stiglitz and Bilmes' benchmark ratio of 2.6 from Vietnam includes only woundings requiring hospitalization (the inner circle in the lower portion of Figure 4). Including woundings from the Vietnam conflict that did not require hospitalization (the second ring in Figure 4) would double the ratio to 5.2, as I calculated and displayed in Table II. But in the absence of data on troops evacuated from Vietnam because of DNBIs, there is no benchmark from

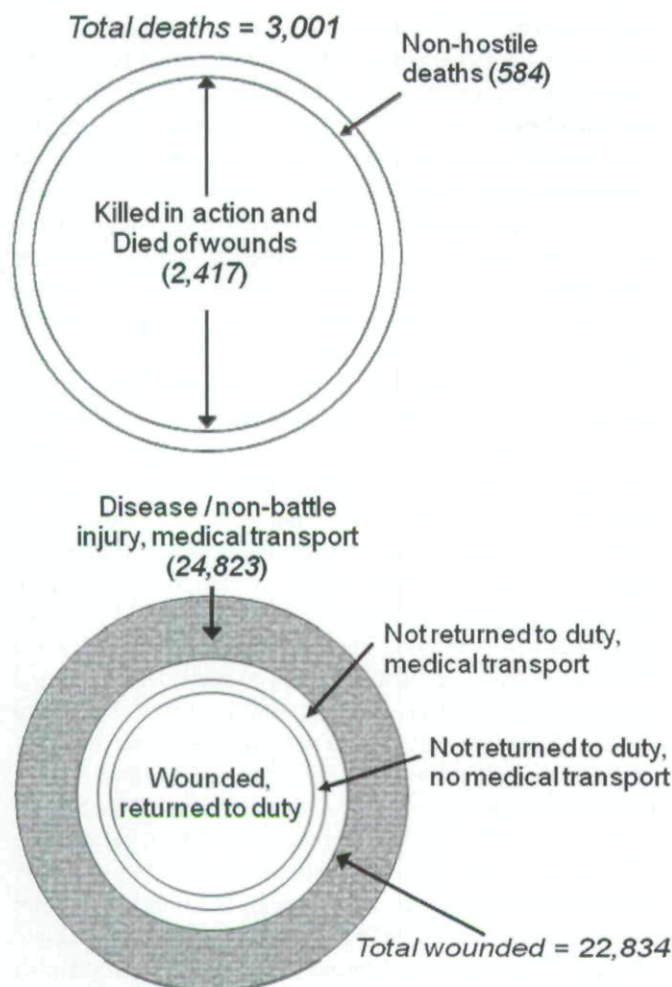


FIGURE 3. Schematic of troops killed and injured in Operation Iraqi Freedom through January 10, 2007.

TABLE II. Wounded-to-Fatality Ratios and Survival Rates for U.S. Troops in Recent Military Conflicts^a

	Vietnam	Iraq (OIF) ^b	Total, OIF and OEF ^b
Wounded/Deaths	5.2	7.6	7.1
Wounded/Hostile Deaths	6.4	9.4	9.2
Wounded Not Returned to Duty/Hostile Deaths	NA	4.2	4.2
Wounded and Hospitalized/Hostile Deaths	3.2	NA	NA
Survival Rates (%):			
All Wounded	86.5	90.4	90.2
Hospitalized or Not Returned to Duty	76.4	80.8	80.6

^aData adapted from Congressional Budget Office.⁸ ^bOperation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF—Afghanistan) statistics are through January 10, 2007.

Vietnam that compares definitionally to the 16-to-1 ratio for Iraq. The only comparable statistics between the two conflicts are the ones I show in Table II, and based on those statistics, the differences between the two conflicts are moderate.



FIGURE 4. Schematic of troops killed and wounded in the Vietnam conflict, 1964 through 1975.

As an alternative way of expressing the same underlying information, I constructed survival rates using a number of wounded troops in the numerator and a denominator equal to the sum of all wounded troops plus those killed in action or who died of their wounds. Among troops wounded and hospitalized (the severely wounded) in Vietnam, 76.4% survived (final row of Table II). The corresponding survival rate was 80.8% among troops not returned to duty within 72 hours in Iraq through January 10, 2007. Among all wounded troops (this time including those who did not require hospitalization or who returned to duty quickly), the survival rates were about 10 percentage points higher: 86.5% in Vietnam and 90.4% in Iraq.

Using either metric, the improvement in survival between the two conflicts is about 4 percentage points. A much larger improvement was reported by Atul Gawande, who computed lethality rates of 24% in Vietnam and 10% in Iraq and Afghanistan.¹⁶ However, Gawande evidently compared the lethality rate of troops hospitalized for their wounds in Vietnam

(1–0.764) to a dissimilar lethality rate of all wounded troops (whether hospitalized) in Iraq and Afghanistan (1–0.902).

DEATH AND INJURY RATES DURING THE SURGE

Estimation of the Population at Risk: How Many Troops Comprised the Surge?

The surge in forces that boosted the U.S. military presence in the Iraq region began around February 2007 and ended in July 2008 when President George W. Bush declared that all additional troops had returned to the U.S.¹⁷ The precise number of troops associated with the surge has been difficult to determine. When announcing the surge during his January 2007 speech, President Bush stated: “So I’ve committed more than 20,000 additional American troops to Iraq. The vast majority of them—five brigades—will be deployed to Baghdad.”¹⁸ During a background briefing at that time, a senior administration official prospectively described the surge as consisting of 21,000 to 22,000 troops.¹⁹ Several newspapers began reporting the size of the surge as 21,500 troops, a figure perhaps obtained by averaging the range in the senior official’s statement.^{20,21} Shortly after President Bush’s announcement, the Congressional Budget Office (CBO) pointed out that combat units require substantial numbers of supporting troops, such that total forces in the region would more likely increase by between 35,000 and 48,000 troops.²²

The DoD Joint Chiefs of Staff reported that between June 2006 and September 2007, ground forces (Army soldiers and Marines) in the Iraq theater (including Iraq proper as well as Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates) increased by 37,900 (from 125,300 to 163,200). According to the same source, total U.S. military forces (excluding Navy personnel aboard ships) increased by 43,500 (from 154,100 to 197,600). The Government Accountability Office (GAO), using data it sources to the Joint Chiefs of Staff and the State Department, reported that between December 2006 and August 2007 total U.S. military forces (apparently in Iraq proper, not the entire theater) increased by 37,000 troops (from 132,000 to 169,000).²³ By either estimate the surge measures at least 37,000 troops and lies within the range predicted by the CBO after accounting for the necessity of support units.

Casualty Rates in Iraq

During the 18-month surge, some 7,058 U.S. troops were wounded in action, 867 were killed in action or died of wounds, and 173 suffered nonhostile deaths. The ratio of WIA to all deaths was 6.8, and the ratio of WIA to hostile deaths was 8.1. Those ratios are lower than the presurge values of 7.6 and 9.4, respectively (see Table II), indicating a decline in survival. More directly, the survival rate fell from the presurge value of 90.4% (see Table II) to 89.1%, a statistically significant drop (odds ratio for wounded versus hostile deaths in the two periods = 0.86 with 95% confidence interval 0.79 to 0.94). Although the drop in the survival rate may appear

modest numerically, the magnitude of the decline implies that about 100 (point estimate = 108, nearly the size of one rifle company) fewer troops survived their wounds during the surge than would have been the case had the (higher) presurge survival rate still prevailed. The incidence of battle injuries, however, was lower during the surge than previously. About 3.2% of soldiers were wounded per year before the surge (3,166 per 100,000—see Table I). DoD’s reports imply an average troop strength of 195,000 in Iraq during the surge. Using that denominator, the WIA rate fell to 2.4% per year, a decline significant at the 7.0% level in a two-sided test.²⁴

The WIA rate during the surge in Iraq (2,409 per 100,000 per year) is more in line with the WIA rate in Afghanistan (about 1,900 per 100,000 per year, measured from October 2001 through July 2008) than with presurge Iraq levels. However, the OEF estimate is approximate because DoD published only fiscal year-end estimates of troop levels in Afghanistan until December 2004, when it began reporting quarterly for that region. The WIA rate in Afghanistan from the end of that month through July 2008 was 2,367 per 100,000 per year, remarkably similar to the WIA rate during the surge in Iraq. Indeed, starting with the presurge count of 23,422 cumulative WIA in Iraq, the OEF WIA rate of 2,367 per 100,000 (calculated from December 2004 through July 2008) closely predicts the 30,480 cumulative WIA in Iraq through July 2008 (Figure 5). The fit is not exact, because the OEF model implies that WIA would accumulate essentially linearly between February 2007 and July 2008 (though not exactly linearly because WIA were projected in proportion to troop levels in Iraq, which peaked at 218,500 in September 2007 and then declined).

As indicated by the concave “bump” in Figure 5, WIA in Iraq accumulated more rapidly than predicted by the model during the first few months of the surge. WIA between

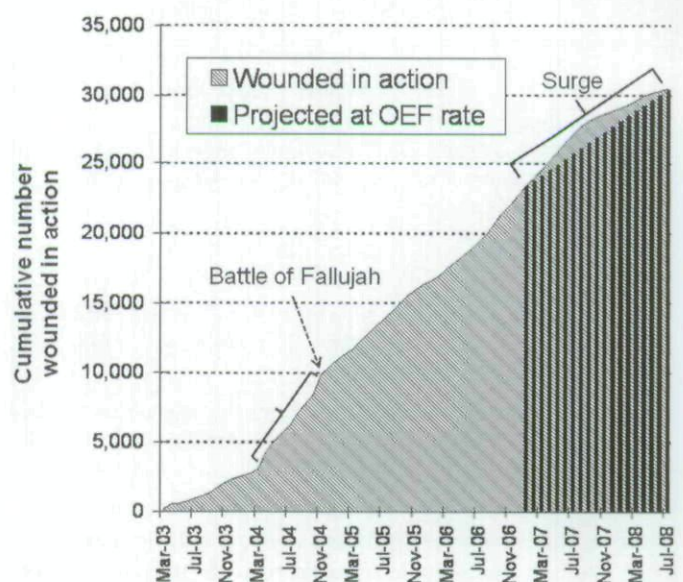


FIGURE 5. Cumulative U.S. military wounded-in-action in the Iraq theater, before and during the surge in forces.

February and August 2007 exceeded the presurge average of 500 per month, peaking at 755 in June 2007 (though still only half of the 1,431 WIA that had been recorded in November 2004 during the Battle of Fallujah, the steepest segment on the cumulative curve). WIA fell during subsequent months, going as low as 143 in June 2008 and 154 in July 2008, enabling the OEF model to fit on average the entire 18-month surge period of February 2007 through July 2008.

One month early in the surge—May 2007—was among only 3 months in the conflict thus far during which more than 120 hostile deaths were recorded. (The other 2 months with like numbers of hostile deaths were April 2004 and November 2004 during, respectively, the events leading up to the Battle of Fallujah and the actual battle; those months are bracketed for emphasis in Figure 5.)

Although insurgents have used improvised explosive devices (IEDs) throughout the entire conflict, other injury mechanisms were relatively more important during the periods of intense fighting. Using amputations as a barometer for severe injuries, the proportion of amputations for which an IED was the mechanism of injury was not particularly high during the deadliest months of the war. In fact, that proportion was at a minimum in November 2004 during the intense Battle of Fallujah; it had been nearly twice as high 2 months earlier, and would climb again to over twice the November level by the following February. Other injury mechanisms, such as gunshot wounds, rocket-propelled grenades, and other types of blast, increased in relative importance during the Battle of Fallujah and again during the surge in 2007; the greater lethality of those other mechanisms correlates to the lower survival rate among troops wounded during the surge.

Although wounds suffered during the surge were somewhat less survivable than previously, there were fewer wounding incidents, and thus perhaps unexpectedly the fatality rate was lower than it had been before the surge. The hostile death (combined KIA/DOW) rate was 335 per 100,000 troops per year before the surge (see Table I) and fell to 296 per 100,000 during the surge. The magnitude of that decline suggests that a total of about 117 hostile deaths (95% confidence interval: 107 to 128 hostile deaths) may have been avoided during the 18-month surge (representing the net effect of 225 fewer troops wounded, partially offset by 108 additional deaths among those wounded because the survival rate dropped from 90.4% to 89.1%). The reduction in mortality began in July 2007, 6 months into the surge and 2 months after the number of brigades had climbed from 15 to its maximum level of 20 (refer back to Figure 2).

BASELINE LEVELS OF DEATH DURING PEACETIME

Not all disease and accidental injury or death that occurs in that combat theater should be attributed to the war, because some number of soldiers would have become ill or suffered accidents had the war not been fought and the soldiers remained in the U.S. under peacetime conditions. Because DoD tabulates

nonbattle injuries and deaths in Iraq during all hours of the day, any peacetime baseline should include off-duty incidents, such as those resulting from commuting or weekend motor-vehicle accidents, as well as training and occupational accidents at the workplace. The average all-cause mortality rate between 1997 and 2000 was 52 per 100,000 active duty military personnel.²⁵ (Deaths due to occupational accidents were a small subset of all deaths during that period, 7.2 per 100,000 active duty military personnel.²⁶) As the U.S. military did not conduct any contingency operations during calendar years 1997 through 2000, the number of deaths among military personnel during that period can be used to estimate the baseline mortality rate.

The nonhostile death rate in Iraq (including deaths due to disease, falls, vehicle accidents, and other causes not directly involving enemy forces) before the surge was 81 per 100,000 troops (Table I, the difference between the total death rate of 416 and the hostile death rate of 335), a 56% elevation over peacetime rate of 52 per 100,000. Stiglitz and Bilmes cited an unpublished study by Harvard graduate student John Horton, who estimated that the nonhostile death rate was elevated by 50% relative to the peacetime baseline.¹⁴ Horton attributed approximately 190 nonhostile deaths in Iraq to the higher mortality rate in that conflict as compared to peacetime, apparently using data partway through 2007 (John Horton, *Army Accident Fatalities Attributable to the War in Iraq*, unpublished paper, Harvard University, Kennedy School of Government, September 2007). I project that there would have been 54 occupational deaths and a total of 394 deaths between March 2003 and March 2007 in a population the size of the deployed military population had it been subject to peacetime mortality rates. Applying my estimate of 56% excess mortality, I estimate that there were 219 excess nonhostile deaths (i.e., nonhostile deaths above that baseline projection) through March 2007 (Figure 6). To place that number in perspective, 219 of the 613 nonhostile deaths (just over one in three) during the first 4 years of the conflict may be attributed to the

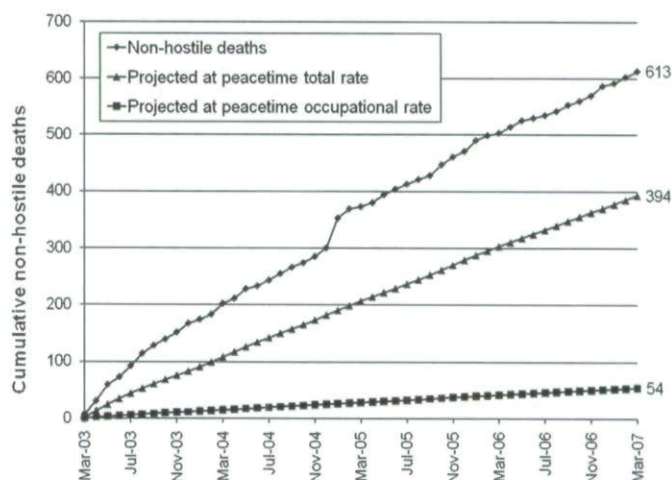


FIGURE 6. Cumulative nonhostile deaths in the Iraq theater and projections under peacetime rates.

higher accidental death rate that prevails during wartime; that estimate is in addition to the 2,628 hostile deaths in Iraq over the same period.

SUMMARY

This article analyzed trends in death and injury rates for U.S. military personnel serving in the Iraq theater, compared those rates to previous conflicts, and considered why different calculations may be appropriate for different purposes. From the invasion of Iraq in March 2003 through January 2007, 90.4% of all wounded troops survived (compared to 86.5% in Vietnam); 80.8% of troops wounded in action and hospitalized in Iraq survived (compared to 76.4% in Vietnam). Wounds suffered during the surge from February 2007 through July 2008 were somewhat more lethal than before the surge (overall survival fell to 89.1%), but the incidence of woundings fell significantly from 3.2% to 2.4% of troops per year. The net effect was a lower hostile death rate during the surge than previously. Lastly, the nonhostile (accidental) death rate in Iraq before the surge was elevated by 56% relative to the peacetime rate for active duty military personnel, implying about 220 excess deaths of that type during the first 4 years of the conflict.

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